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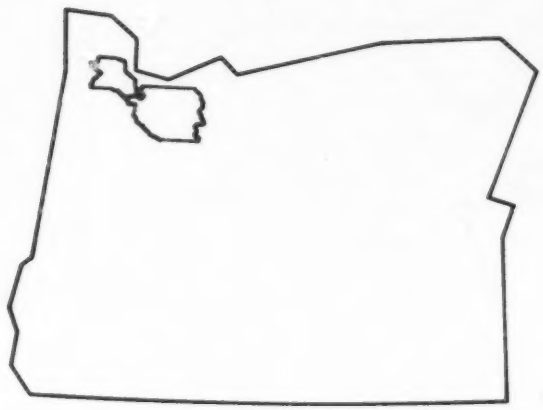
FLOOD INSURANCE STUDY

ORIGINAL

CITY OF RIVERGROVE, OREGON

CLACKAMAS AND WASHINGTON COUNTIES



AUGUST 4, 1987

Federal Emergency Management Agency

COMMUNITY NUMBER - 410022

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for flood plain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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Tualatin River Panel 01P

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Rivergrove, Washington and Clackamas Counties, Oregon, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by James M. Montgomery, Consulting Engineers, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-4582. This work was completed in November 1984.

The U.S. Army Corps of Engineers (COE), Portland District, completed a channel improvement project in 1983 within the reach of the Tualatin River directly upstream of Rivergrove. This study is based on the analysis performed by the COE to reflect the Tualatin River channel improvement.

1.3 Coordination

Areas to be studied by detailed methods were identified at a meeting held in June 1977, and attended by representatives of FEMA, the study contractor, and the City of Rivergrove.

Results of the hydrologic analyses for this study were coordinated with the COE, U.S. Geological Survey (USGS), and U.S. Soil Conservation Service.

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Preliminary results of the study were presented at an intermediate community coordination meeting held on May 10, 1984, and attended by representatives of the community, study contractor, and FEMA.

On August 21, 1986, the results of the study were discussed at the final community coordination meeting, which was attended by representatives of FEMA, the study contractor, and the community. All significant problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Rivergrove, Washington and Clackamas Counties, Oregon. The area of study is shown on the Vicinity Map (Figure 1).

Flooding caused by overflow of the Tualatin River within the corporate limits of Rivergrove was studied by detailed methods.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through November 1989.

2.2 Community Description

Rivergrove is a southern suburb of Portland, in the northwestern corner of Clackamas County, in northwestern Oregon. The total land area contained within the corporate limits is 0.16 square mile. According to U.S. Census Bureau figures, the population increased from 319 when the city was incorporated in 1971 to 350 in 1979 (Reference 1).

The Tualatin River, which flows easterly through Rivergrove and forms its southern corporate limits, is a major tributary of the Willamette River. The Tualatin River extends from its source in the Coast Range Mountains (at an elevation of 3,400 feet) to its mouth at the Willamette River. The total drainage area of the Tualatin River is 711 square miles, approximately 690 square miles of which are upstream of Rivergrove.

Approximately 63 percent of the city has been developed. Development within the Tualatin River flood plains studied is residential. Fifty-five percent of the housing in the city lies within the flood plain (Reference 2).

The climate is characterized by warm, dry summers and mild, wet winters. Temperatures are usually moderate, ranging from an average monthly minimum in January of 40°F to an average monthly maximum in July of 85°F. The average annual precipitation is 55 inches, with 85 percent occurring from October to May.

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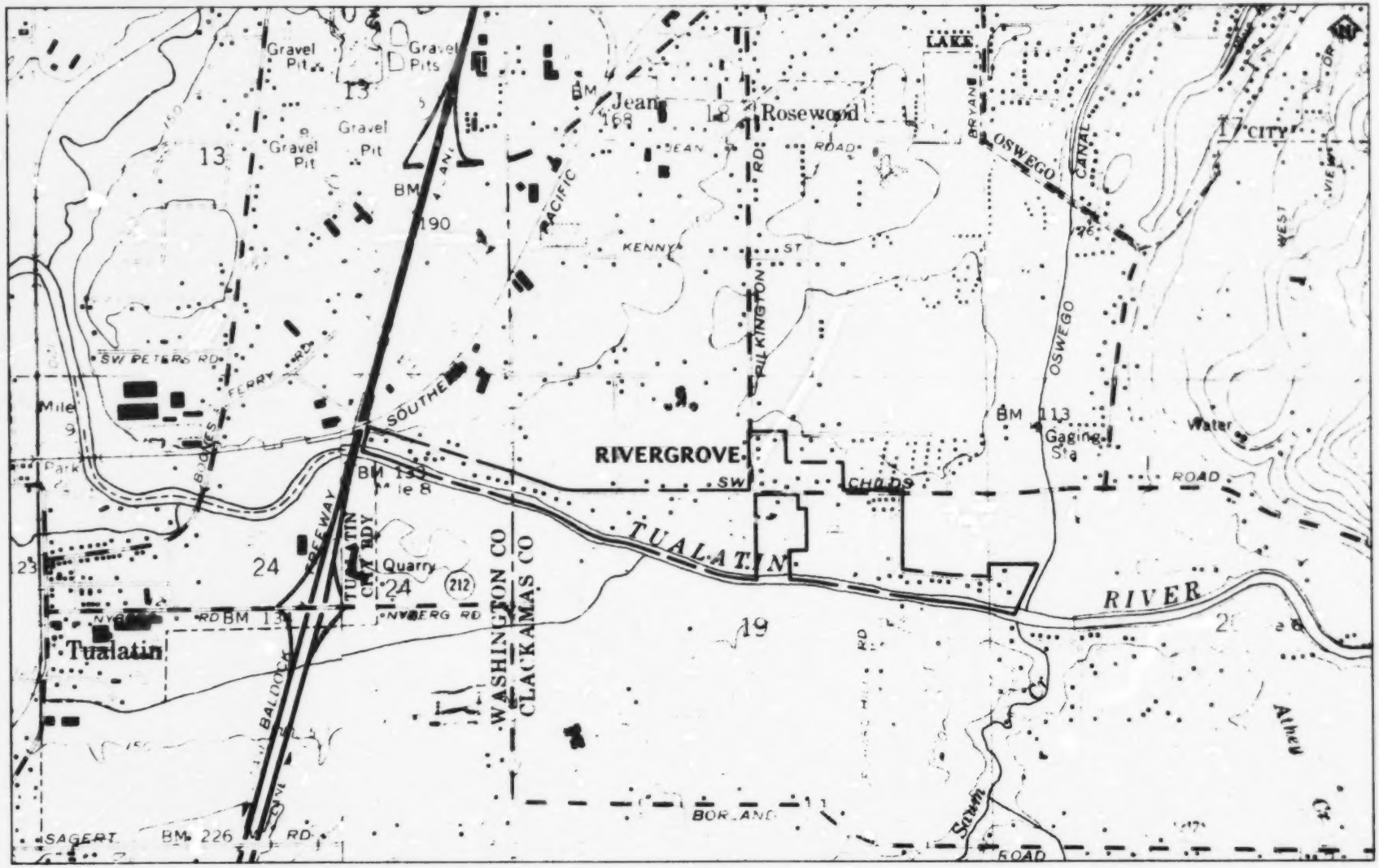

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RIVERGROVE, OR
(CLACKAMAS AND WASHINGTON COS.)

APPROXIMATE SCALE
1600 0 1600 3200 4800 FEET

VICINITY MAP

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Located in the Tualatin Valley, the topography of Rivergrove is relatively flat and gently sloping. Soils in the area have poor drainage characteristics. Trees, grass, and shrubs are the predominant vegetation.

2.3 Principal Flood Problems

Historically, flooding within Rivergrove normally occurs during the winter and spring. The larger floods on the Tualatin River have resulted from abnormally heavy or prolonged rainfall, combined with snowmelt and frozen or nearly saturated ground surface.

During the flooding season (October through April), cyclonic storms from the Pacific Ocean sometimes produce intense rainfall on the drainage basin. When these storm fronts move downstream, greater discharges are produced. If this condition is accompanied by rapid snowmelt and frozen ground in the upper watersheds, large floods can result.

Major floods have occurred on the Tualatin River. The largest recent flood occurred on January 18, 1974, with a peak discharge of 21,400 cubic feet per second (cfs) (Reference 3). The largest recorded flood occurred on December 23, 1933, with a flow at the West Linn gage of 23,300 cfs. The estimated 100-year floodflow at the West Linn gage on the Tualatin River is 23,455 cfs.

2.4 Flood Protection Measures

One multipurpose storage project is available for flood control in the Tualatin River basin. Henry Hagg Lake Project, constructed by the U.S. Bureau of Reclamation, began operation during the 1974-1975 flood season. It provides 30,000 acre-feet of flood storage, starting in November each year. Flood-storage capacity is reduced as the winter flood season terminates and the reservoir is filled each spring in anticipation of the summer irrigation demand. The effect of Henry Hagg Lake Project flood storage has been considered in the calculation of water-surface profiles for the Rivergrove segment of the Tualatin River. However, this storage facility is far enough upstream from Rivergrove, approximately 50 river miles, that the it would have a negligible effect on the 100- and 500-year floods.

The U.S. Bureau of Reclamation has completed a draft feasibility study of two alternative storage projects on the Tualatin River near the Town of Gaston that could provide additional flood storage in the Tualatin River basin. Those projects, however, are still in the planning stages and are not reflected in the data presented in this study.

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Regulatory measures have been adopted by Rivergrove to guide new development in the flood plain consistent with the hazards involved (Reference 2). New residential development must be adequately protected from flooding, and development within the floodway that would hinder flow is not permitted.

River stage forecasting for the Tualatin River is the responsibility of the Portland River Forecast Center (PRFC) and the National Weather Service. Forecasts and flood warnings prepared by the PRFC are disseminated through Clackamas County Emergency Services, radio, television, and other news media.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding source studied by detailed methods affecting the community.

Tualatin River stream gage records were statistically analyzed using the log-Pearson Type III distribution, as outlined by the U.S. Water Resources Council (Reference 4). Discharge-frequency curves for the USGS stream gages at West Linn and Farmington were developed using records from 1938 to 1976 and from 1939 to 1958, respectively. Because of the relatively short record at Farmington, floodflow-frequency statistics at this station were adjusted by use of the long-term station data at West Linn. Discharges were adjusted for flood-control storage furnished by Henry Hagg Lake Project.

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Peak discharge-drainage area relationships for the Tualatin River are shown in Table 1.

Peak Tualatin River discharges near the downstream corporate limits of Rivergrove were reduced to reflect flows into Oswego Canal via an area of relatively low elevation along the left bank and a diversion dam and outlet works. The Oregon Iron and Steel Dam at River Mile (R.M.) 3.4 and its outlet works at R.M. 6.7 divert Tualatin River flow into Oswego Canal to stabilize the Lake Oswego water level. USGS has maintained a stream gage on Oswego Canal since 1928 to measure outflow from the Tualatin River. Flows into Oswego Canal for various frequency floods were determined by a trial-and-correction computer process using observed 1974 flood elevations.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Hydraulic analyses were performed using the COE HEC-2 step-backwater computer program (Reference 5). The Tualatin River cross section data used in the program were from COE field surveys. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Hydraulic roughness values (Manning's "n") for the channel and overbanks were first estimated from field observations. The "n" values for the Tualatin River were then modified to match January 1974 high-water marks. The final calibrated "n" values for the Tualatin River varied from 0.047 to 0.050 for the channel and from 0.063 to 0.120 for the overbank.

Starting water-surface elevations for the Tualatin River were calculated by the slope-area method at its confluence with the Willamette River.

Results of the hydraulic analysis using the 100-year flood discharge indicated that flooding across the left overbank between the Tualatin River and Oswego Canal would be wide and shallow. Elevations and the corresponding average depth along this area were estimated by linear interpolation between the 100-year flood elevations at the breakout point along the Tualatin River and the point of inflow into Oswego Canal.

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Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Tualatin River					
At USGS Gage at West Linn (R.M. 1.8)	706	15,000	20,740	23,455	29,370
At Southern Pacific Railroad Crossing in Tualatin (R.M. 8.8)	686	15,200	22,700	27,000	37,800

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The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet, enlarged to a scale of 1:2,400 (Reference 6).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment

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so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodway in this study is presented to local agencies as the minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

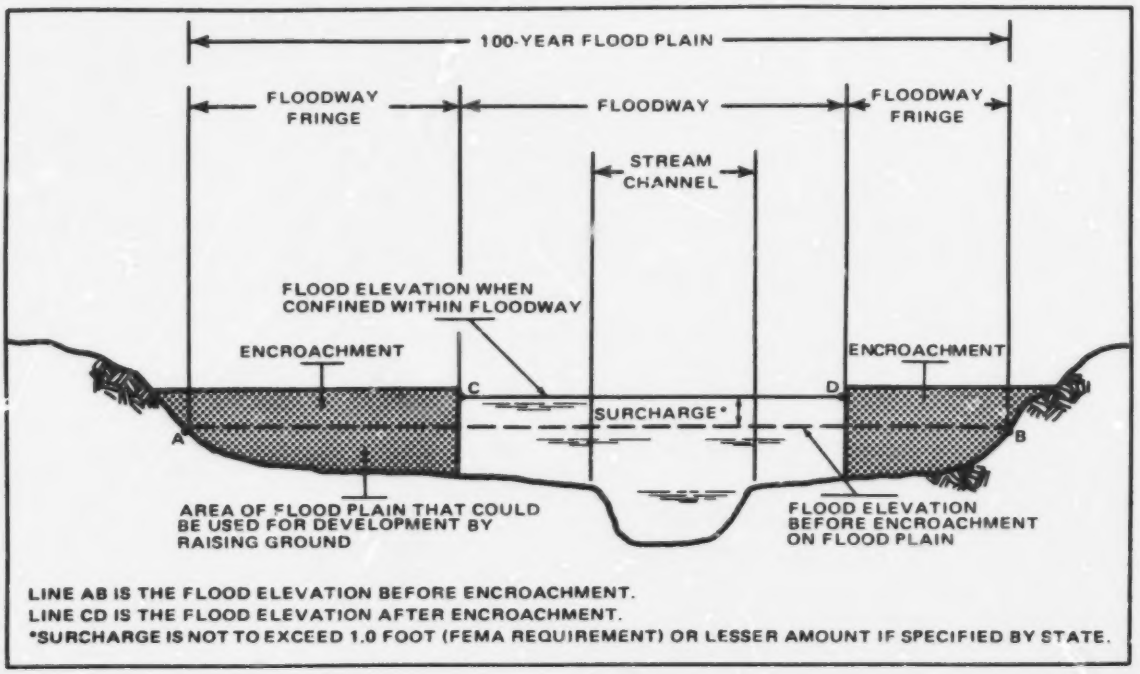
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 2. Floodway Schematic

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Tualatin River								
A	35.695	235/115	5,838	4.4	119.8	119.8	120.3	0.5
B	40.765	244/100	5,747	4.0	122.1	122.1	122.8	0.7
C	41.915	215/90	5,400	4.3	122.3	122.3	123.0	0.7

[1]Feet Above Confluence With Willamette River [2]Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RIVERGROVE, OR
(WASHINGTON AND CLACKAMAS COS.)

FLOODWAY DATA

TUALATIN RIVER

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Tualatin River							
Reach 1	**0001**	**5.0**	**-1.5**	**3.3**	**050**	**A10**	**Varies - See Map**
Shallow Flooding	**0001**	**N/A**	**N/A**	**N/A**	**N/A**	**A0**	**Depth 2**

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RIVERGROVE, OR
(WASHINGTON AND CLACKAMAS COS.)

FLOOD INSURANCE ZONE DATA

TUALATIN RIVER

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5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied by detailed methods affecting the City of Rivergrove.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard. In riverine areas, reaches are based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The location of the reach determined for the riverine flooding source of Rivergrove is shown on the Flood Profiles (Exhibit 1), and the reach is summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10-and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

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Zone A0:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown, but no FHFs are determined.
Zones A10:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flood hazard; not subdivided.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the Tualatin River within the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Rivergrove is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

6.0 OTHER STUDIES

Flood Insurance Studies have been published for the City of Durham (Reference 7) and the unincorporated areas of Washington County (Reference 8); Type 19 restudies from the unincorporated areas of Clackamas County (Reference 9) and for the City of Tualatin (Reference 10) have also been published. The results of this study match the results of the cited studies exactly.

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Flood Plain Information reports were prepared for the Tualatin River through Washington County and the Milwaukie-Oak Grove-Lake Oswego area in 1969 and 1970, respectively (References 11 and 12, respectively). The 100-year flood profiles for the Tualatin River vary approximately 1 foot between the Flood Plain Information reports and this study. The difference in flood heights is attributed to the improved data obtained for this study.

Because more detailed methods and updated information were used, this study supersedes the Flood Hazard Boundary Map published for the city (Reference 13).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Federal Regional Center, 130 228th Street, SW., Bothell, Washington 98021-9796.

8.0 BIBLIOGRAPHY AND REFERENCES

1. Oregon State Board of Census, Certificate of Population Enumerations and Estimates of Counties and Incorporated Cities of Oregon, September 22, 1960, July 1, 1977

2. City of Rivergrove, Comprehensive Plan, Amendment, June 1, 1982

3. U.S. Department of the Interior, Geological Survey, Magnitude and Frequency of Floods in the United States, Part 14

4. U.S. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17A, June 1977

5. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water-Surface Profiles, Davis, California, January 1981

6. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Map, Scale 1:24,000, Contour Interval 10 feet: Lake Oswego, Oregon (1961), Photorevised (1970 and 1975)

7. Federal Emergency Management Agency, Flood Insurance Study, City of Durham, Washington County, Oregon, January 6, 1982

8. Federal Emergency Management Agency, Flood Insurance Study, Washington County, Oregon (Unincorporated Areas), September 30, 1982

9. Federal Emergency Management Agency, Type 19 Flood Insurance Study, Clackamas County, Oregon (Unincorporated Areas), August 4, 1987

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10. Federal Emergency Management Agency, Type 19 Flood Insurance Study, City of Tualatin, Washington and Clackamas Counties, Oregon, February 19, 1987

11. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Washington County, Oregon, June 1969

12. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Milwaukee-Oak Grove-Lake Oswego, Oregon, May 1970

13. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Rivergrove, Oregon, April 22, 1977

Chow, Ven Te, Handbook of Applied Hydrology, New York: McGraw-Hill Book Company, 1964

U.S. Department of Commerce, Weather Bureau, Daily River Stages

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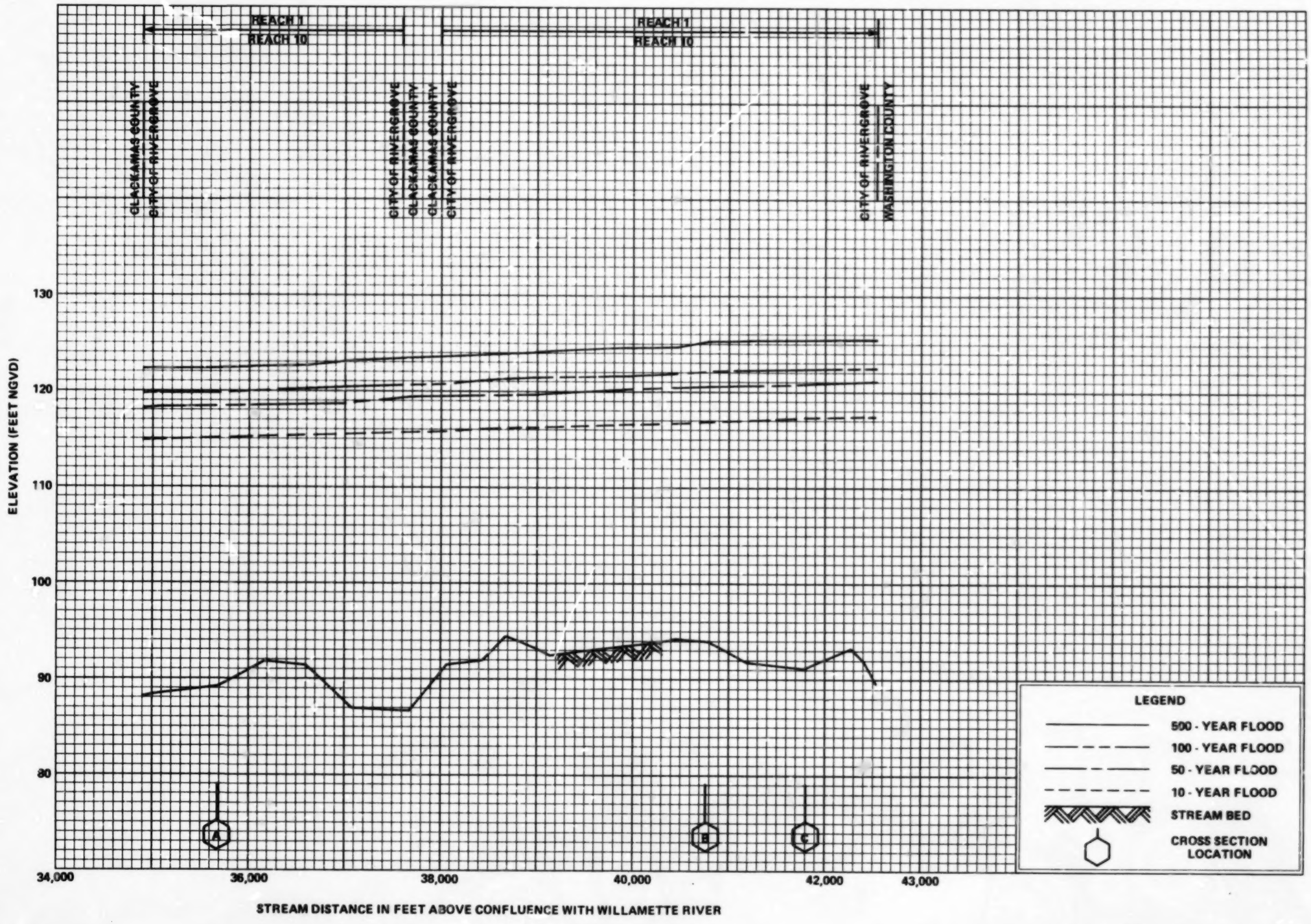

FLOOD PROFILES

TUALATIN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RIVERGROVE, OR
(CLACKAMAS AND WASHINGTON COS.)

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